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The impact of age on Italian consumers' attitude toward alternative fuel vehicles

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ABSTRACT

Addressing environmental problems requires large-scale transition efforts in the transport sector. Many governments, encouraging sustainable mobility, see alternative fuel vehicles as an important part of a technology portfolio targeted at reducing polluting emissions. However, consumers' adoption of alternative fuel vehicles is hindered by complex technical and socio-economic aspects. The novelty of this study is to explicitly explore the impact of age on consumers' attitudes towards alternative fuel vehicles with an original questionnaire survey, targeting a sample of high-educated Italian consumers. We identify the main concerns related to alternative fuel vehicles and suggest measures to overcome these concerns. A better understanding of the effects of different ages on attitude processes is crucial for designing more effective private and public strategies for alternative fuel vehicles' development across a variety of consumers.

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1. Introduction

The transport sector exerts a significant pressure on the environment and human health through air emissions, noise and climate change. The environmental impact of the transport sector depends on three main factors: the frequency of trips and distances, the mode of transport used, as some are more environmentally friendly than others, and the technologies used by each mode. To address these issues, environmental policies are mainly aimed at switching the type of fuel used in vehicles to reduce emissions and thus lead to a low-carbon society, spurring the use of alternative fuels such as biofuels, natural gas and electricity. In this paper, we specifically consider alternative fuel vehicles (AFVs), including battery electric vehicles (BEVs), hybrid electric vehicles (HEVs) and plug-in hybrid electric vehicles (PHEVs). These are all promising technologies that, using electricity, could replace a significant portion of the global fleet's petroleum consumption and mitigate emissions and security issues related to oil extraction, importation and combustion [1]. BEVs run exclusively on electricity using on-board batteries, while HEVs and PHEVs add a battery and electric motor to cars that employ internal combustion engines.

The aim of this paper is to explore the impact of age on consumers' attitude toward AFVs, using a sample consisting of two age groups, i.e., students and faculty members of the University of Perugia, Italy. Our sample can be interpreted as a proxy for the characteristics of early adopters, because individuals with medium to high level of education might have the ability to understand how-to" knowledge a new technology more quickly than those with less education [2]. Our paper pursues descriptive goals in an effort to characterize attitudes toward AFVs. Our paper pursues descriptive goals in an effort to characterize preferences toward AFVs.

Despite technological developments in AFVs, they have only tapped a small fraction of their potential to date [3,4]. There are several technological challenges to be overcome in terms of weight, volume, manufacturability, reliability, safety and durability to achieve the expected performance and efficiency of AFVs [5,6]. Current maintenance and fuel supply infrastructures are mainly oriented towards conventional fuel vehicles, i.e., gasoline and diesel vehicles [7,8].

Consumers' behaviour towards the purchase of AFVs is ambiguous. Table 1 shows, on the one hand, some advantages perceived by consumers, and, on the other hand, the variables for which consumers are mostly reluctant to buy AFV (see all the references listed in Table 1).

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Table 1
Literature review on consumers' attitudes towards AFVs.

Authors	Country	Year	Vehicle	Method	Pros	Cons	Main findings	Policy implications
Egbue and Long [3]	USA	2010	BEVs	Internet	Fuel savings; less maintenance; environmental benefits.	Battery range; high cost; charging infrastructure.	Attitudes and perceptions differ across gender, age and education.	Need to address socio-technical barriers.
Krause et al. [9]	USA	2011	AFVs	Internet	-	Maintenance costs, cost premium.	High degree of misperception about the basic features of AFVs; low rate of awareness of incentives.	More knowledge of AFVs to increase consumer interest.
Hackbarth and Madlener [24]	DE	2011	AFVs	Internet	Fuel savings; emissions reduction.	Driving range, charging infrastructure, cost.	Younger, well-educated and environmental car buyers are more sensitive to the adoption of AFVs.	Need for substantial subsidisation of the AFVs purchase.
Ozaki and Sevastyanova [10]	UK	2009	HEVs	Mail	Financial and environmental benefits.	-	Strong effect of financial benefits on purchase decision.	Transport policy should focus on congestion charge exemptions and other financial incentives.
Krupa et al. [11]	USA	2011	PHEVs	Internet	Energy independence; environmental benefits; financial savings.	Battery technology issues.	Fuel cost savings and climate change are important in considering PHEVs purchase.	Raising consumer awareness of tax incentives.
Morton et al. [12]	UK	2011–2012	BEVs	Field interviews	Running costs; attractiveness of decentralised fuelling at home.	Reliability; safety; complexity; lack of performance.	Symbolic and instrumental meanings negatively affect BEV evaluations.	Improving the knowledge of BEVs in society to reduce negative evaluations.
Bühler et al. [13]	DE	2009–2010	BEVs	Field interviews	Low noise emissions; low refuelling costs; environmental friendliness.	Limited range; charging; low noise level as safety issue.	Experience can significantly change the perception of the advantages of BEVs.	Some new marketing strategies are required.
Larson et al. [14]	CA	2011–2012	AFVS	Field interviews	Battery range that meets daily needs; ability to charge battery at home.	High purchase price; vehicle reliability; high battery cost.	Consumers are unwilling to pay substantial premiums for AFVs.	Need for sponsoring research and educating consumers.
Lebeau et al. [15]	BE	2011	BEVs	Internet	Low cost per km; environmental friendliness; ability to charge at home.	High purchase price; limited driving range; limited charging infrastructure.	Consumers desire faster charging durations.	Standardisation of the charging infrastructure and exemption of taxes.
Hidrue et al. [16]	USA	2009	BEVs	Internet	Fuel economy; pollution reduction.	Driving range; charging time; performance.	A person's propensity to buy BEVs increases with youth, education, green life style.	Battery costs need to drop considerably.

AFVs = Alternative fuel vehicles (battery electric vehicles, hybrid electric vehicles and plug-in hybrid electric vehicles); BEVs = battery electric vehicles; HEVs = hybrid electric vehicles; PHEVs = plug-in hybrid electric vehicles.

The major economic obstacles to the introduction of AFVs are related to the costs, which are higher than those of conventional fuel vehicles. Although electricity costs are much lower than petroleum fuel costs, this difference is not sufficient to compensate for the higher upfront costs required for the purchase of AFVs compared to conventional fuel vehicles. However, new technological developments are expected to be implemented in the near future that will reduce costs and improve AFVs efficiency. In any case, price of AFVs may influence consumers' willingness to adopt AFVs [17]. As a result, we can deduce our first hypothesis of this paper:

Hypothesis 1. The higher the price of AFVs is, the more consumers are willing to buy them.

Besides high purchase price, long charging time is considered a disadvantage by potential consumers, decreasing intent to purchase. Recharging time can be addressed by developing other technologies, such as superfast charging systems, battery pack swaps, but such efforts can be justified only if there are many AFVs in use. This is like a dog chasing his own tail. As a result, we can deduce our second hypothesis:

Hypothesis 2. Longer charging times negatively affect consumers' willingness to adopt AFVs.

So far, few studies have focused on the importance attributed to certain vehicle features in relation to age, with controversial results (see among others [18–20]). Features, such as safety and reliability, are considered more important than others for older consumers

when considering the purchase of a vehicle [21,22]. Johansson-Stenman and Martinsson [23] found that people care about their self-image, with younger drivers being more attracted by high performance vehicles that could improve their image. In this context, AFVs, as green products, offer an important status, thus providing a reputational benefit; such goods enable people to appear more pro-social rather than pro-self [59,60]. As a result, we can deduce our third hypothesis:

Hypothesis 3. Students who care about their self-image, are more willing to buy AFVs.

Hackbarth and Madlener [24]; analysing the potential demand for privately used alternative fuel vehicles in Germany, found that younger, highly educated, and environmentally conscious consumers, are more willing to buy AFVs. Literature has considered concern for the environment as a key variable to explain consumers' willingness to adopt AFVs [25]. However, other authors [26] showed that, even though many consumers want to purchase an environmentally friendly vehicle such as AFVs, only few of them state they are very willing to pay a premium for these types of vehicles. As a result, we can deduce our fourth hypothesis:

Hypothesis 4. Environmentalism is a bad predictor of adoption levels.

Our paper contributes to the literature in an innovative way by identifying factors which may have important positive influence on consumers' attitudes towards AFVs in relation to age groups.

The paper proceeds as follows. Section 2 describes the methodology applied and the data, highlighting the AFVs' Italian context and the survey conducted. Section 3 presents the results. Section 4 concludes and discusses the policy implications.

2. Methods and data

2.1. The EU context

Meeting the challenge of reducing energy consumption and carbon dioxide emissions poses difficulties that the transport industry cannot tackle only with internal combustion engines. Within Europe, the European Union (EU), through the Renewable Energy Directive 2009/28/EC [27], has set a target of at least a 10% share of renewables in the final energy consumption of the transportation sector by 2020. The European Green Vehicles Initiative, a public–private partnership dedicated to delivering green vehicles and mobility system solutions, estimates a 10% market share for AFVs in 2025 in the EU, compared to the current 1.3%.

Worldwide, total vehicle sales have shown a growing trend during the past decade, with the exception of 2008 and 2009, when the market was affected by the economic crisis. Between 2007 and 2014, however, sales increased by 28.5% globally. In the EU, overall vehicle sales peaked in 2007 at 19.6 million cars and then started to decline substantially until 2013, when only 15.9 million cars were sold. For the EU vehicle fleet, the decline in the 2007–2014 period was 17.8%. In Italy, total vehicle sales also followed the European trend, peaking in 2007 with 2.49 million cars, followed by a continuous drop until 2013, when only 1.3 million vehicles were sold, a decline of 45.3% decline for the 2007–2014 period.

In a global automotive market that is measured in the tens of millions of units per year, the market for AFVs sales represents only a small proportion. The AFV market began to take off in 2011. In 2014, around 320,000 AFVs were sold globally, and the cumulative sales amounted to 740,000 by the end of 2014. Currently, the AFV country-level market shares show a dominance of the USA, which accounts for 46% of the global AFVs sold, followed by Japan (27%), the EU (18%) and China (8%). In Italy, 1.36 million vehicles were sold in 2014, of which 21,387 were AFVs (about 1.6% of the total, almost all of which were HEVs and PHEVs) [28]. Although it is hard to accurately forecast the penetration of AFVs in the vehicle market in the near future, if the pace of growth continues to increase as in recent years, EU sales could reach over 2 million units by 2030.

Currently, much emphasis is placed on the need to develop an extensive grid of public charging infrastructure as an important element to spur AFV demand. In line with a specific EU Directive (2014/94/EU) of the European Parliament and of the Council of 22 October 2014 [29], the Italian Ministry for Infrastructure and Transport signed a decree to implement a National Plan of Infrastructure for charging AFVs. The plan defines the guidelines for ensuring the development of charging services for AFVs in the national territory, and it involves two main steps. The first phase, from 2013 to 2016, is aimed at introducing both a minimum size for AFVs and basic private and public charging station infrastructures, the definition and implementation of policies to promote the development of AFVs and incentives for technological development. In order to finance the National Plan, the Italian Ministry of Infrastructure and Transport has provided almost 120 million € for the years 2013–2016. For instance, government incentives for vehicles purchased in 2015 were equal to 15% of the total cost of the AFVs (before tax), with a maximum of 3500 € for vehicles with carbon dioxide emissions below 50 g/km, 3000 € for vehicles with carbon dioxide emissions below 95 g/km and 1800 € for vehicles with carbon dioxide emissions below 120 g/km. The second phase, from 2017 to 2020, will be the consolidation of AFV standards on a large scale, with the aim of introducing common and shared rules among the EU Member States, deploying AFVs and completing and consolidating the public and private charging grid infrastructure.

2.2. Survey and data collection

The questionnaire (shown in Appendix) has been designed according to the theory of planned behaviour, which allows us to investigate the actual behaviour as the result of attitude towards behaviour, subjective norms and perceived control over the behaviour [30]. Attitude can be defined as the sustained evaluations, feelings, and tendencies that consumers exhibit regarding objects or ideas [31]. Subjective norms are defined as the degree of social pressure felt by the person with regard to the behaviour. Perceived control over the behaviour refers to an individual's perception of the possible difficulties when performing a specific behaviour (Chen and Tung, 2014). Many researchers have used the theory of planned behaviour model to study ecological behaviours and eco-friendly purchasing decisions [32–34]. Thus, in line with the theory of plandned behaviour, we assume that individuals with altruistic values and concerns about environmental issues are likely to believe that AFVs improve the environment by, for instance, reducing air emissions [35,36].

Perugia is a good case study to test our research in regards to the Italian vehicle market, as it is located in the centre of Italy, nestled halfway between Rome and Florence. The city is home to one of Europe's oldest universities, which is also one of the most accredited national universities within the Italian context. However, besides its geographical location, this study focuses on the city of Perugia for several reasons. Among them, Perugia is known in Italy for its alternative mobility policies, which focus on technological innovation and environmental sustainability, from the innovative accessibility system in the historical city centre (i.e. escalators) to the realisation of the first city rail system and the design of a bike-sharing system with pedal assistance. Indeed, given its historical and geographical characteristics, Perugia has a road

system that does not promote pedestrian mobility and does not have good public transportation. Therefore, there have been various experiences of alternative mobility, with positive results.

We have employed a web-based questionnaire survey, involving a sample of Italian students (average age 20 years) and professors (average age 52 years) of the University of Perugia, from February to July 2015. Following Angeliki et al. [37]; we have previously piloted the web-based questionnaire on a smaller sample of respondents (both student and faculty members) to assure wording and content validity.

We used Pearson's chi-square test to test for differences between the two groups about attitudes toward AFVs. On the one hand, there were significant differences attributable to environmental (decrease the use of oil, climate change mitigation) as well as some technological (less maintenance than conventional vehicles, charging time, battery exchange system) variables. These results suggest that age differences between students and faculty members yield different environmental attitudes (and then different environmental behaviours). Besides, the technological variables – charging time and battery exchange system – may reflect differences in individuals' perception of time. On the other hand, comparison across students and faculty members indicates there are no significant differences in terms of other specific technological variables, such as lower refuel costs than conventional gasoline vehicles, comfort, environmental performances, separating batteries from AFVs.

The individuals were asked about their age, their knowledge about AFVs, their perceptions about the relative price of AFVs and their perceptions about the technical features of AFVs. These questions on various issues related to consumers and AFVs were assessed on a five-point Likert scale ranging from 1 = strongly disagree (never) to 5 = strongly agree (always).

Data for the study were gathered in the following way. For university students, printed copies and a web-based questionnaire were both collected. The printed copies of the questionnaires were distributed in the university campus, while the web-based questionnaire was published on the university's website. A link to the questionnaire was sent by email to a mailing list including all the professors of the University of Perugia (985 total in 2015) so that they could fill out the questionnaire online via the web. On average, the questionnaire required 30 min to complete. Questionnaires with missing values for the main variables were discarded. A total of 421 valid responses were successfully obtained, of which 316 were from students and 105 were from professors. Regarding the university students' profile, 55% were male and 45% were female. A total of 86% of the students were from the area of Perugia while 14% were from the rest of Italy. The annual household income was <10,000 € for 9% of the students, between 10,001 € and 20,000 € for 25%, between 20,001 € and 30,000 € for 18%, between 30,001 € and 40,000 € for 14% and >40,001 € for 34%. The majority of the students (67%) reported they are car drivers travelling, on average, < 30 km daily, 9% between 31 km and 40 km and 24% > 41 km. In regard to the university professors, 61% were male and 39% were female. The annual household income was between 10,000 € and 20,000 € for 3% of the professors, between 20,001 € and 30,000 € for 16%, between 30,001 € and 40,000 € for 38% and >40,001 € for 43%. Half of the respondents (50%) indicated that they drive < 20 km, 22% drive between 21 km and 50 km and the remaining 28% drive > 51 km.

3. Results and discussion

In this section we present results of the questionnaire survey to investigate the impact of age on Italian consumers' willingness to adopt AFVs.

In order to explore consumers' familiarity with AFVs, all respondents were asked whether they had ever had a driving experience with the different types of AFVs, as shown in Fig. 1.

The results revealed that most of the respondents had never tried AFVs (77% for students and 78% for faculty members), while 16% and 12% of the students and faculty members had tried HEVs, respectively; only a small number of the respondents had tried BEVs (4% students, 5% faculty members) or PHEVs (2% students, 5% faculty members). A possible explanation for these results is that few AFV promotional campaigns have been conducted in Italy, and even more specifically in the city of Perugia. Indeed, promotional campaigns for car drivers, fleet managers and major stakeholders could encourage behavioural changes and influence the individual propensity to purchase AFVs. However, in contrast, when asked to express their interest and curiosity regarding AFVs as a new technology, only a few of the respondents had no interest (8% students, 7% faculty members) or little interest (19% students, 18% faculty members) while the remainder showed a medium to very high interest, as detailed in Fig. 2.

Our results show that there is a medium-high degree of interest in AFVs, meaning that there is a generally positive understanding of and favourable attitude toward the concept of AVS. It should be stressed that the level of interest of faculty members is higher than that of students; nearly 50% of faculty members showed a high or very high interest, whereas only 35% of students had the same level of interest. These findings are consistent with the empirical literature from other countries (see among others [38]), which shows that individuals who are more interested in AFVs are also more likely to be more mature – an outcome that shows how important it is to educate youths, the future generation, on AFVs. Kumar [39]

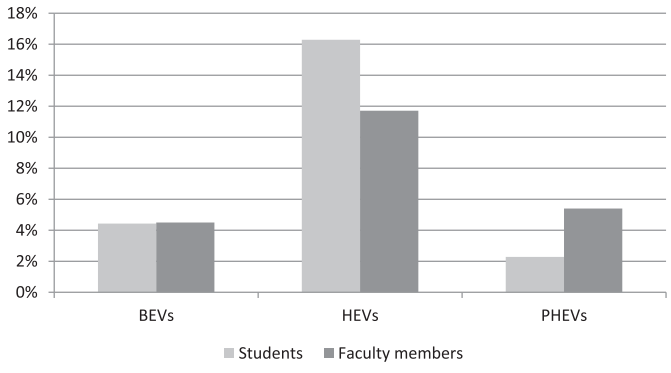

Fig. 1. Type of AFVs tried by respondents.

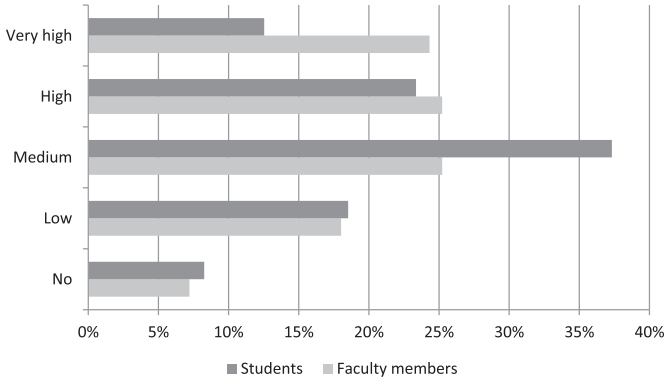

Fig. 2. Level of respondents' interest in AFVs.

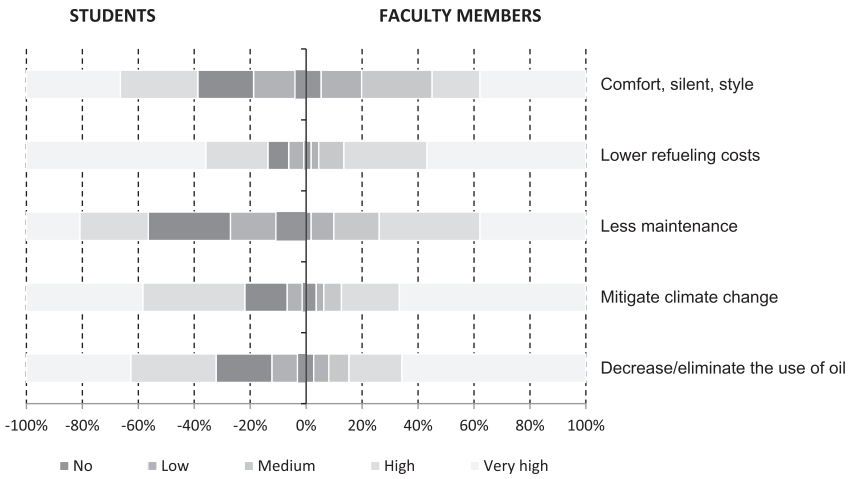

Fig. 3. Respondents' assessment of the relevance of AFV features.

conducted an interesting study based on a one-day program, with the purpose to introduce school children to the environmentally friendly AFV industry. This study discovered that some interest could be induced in young subjects, following the so-called 'catch them young' model, in the hopes that they might become customers while they are still young.

According to recent studies, the combination of high oil costs, concerns about oil security and availability and air quality issues related to vehicle emissions are driving interest in AFVs [40–42]. For AVFs to be feasible substitutes for conventional vehicles, they need to have superior environmental benefits, be economically competitive and provide a net energy gain after factoring in the energy required to manufacture them [43,44]. Considering the aforementioned, we asked the respondents for their assessment of specific features related to AFVs (Fig. 3).

The majority of the students (64%) and faculty members (57%) consumers indicated that they were strongly attracted by the reduction in refuelling costs associated with AFVs compared to conventional vehicles, meaning that the concern for costs was generally felt with high intensity by the majority of the respondents. Comfort, silent operation, style and less maintenance were factors that did not have a strong effect on the overall sample. In contrast, environmental features such as climate change mitigation and reduced oil consumption were strong factors leading to the adoption of AFVs by faculty members (66–67%), although a lower proportion of students were influenced by such features (37–41%). These responses highlight that high education is a

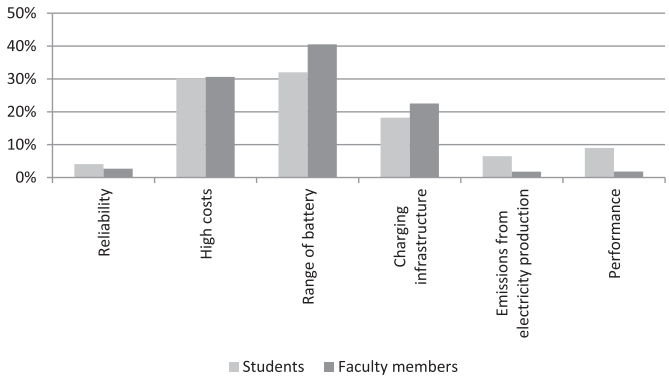

Fig. 4. Main concerns of the respondents about AFVs.

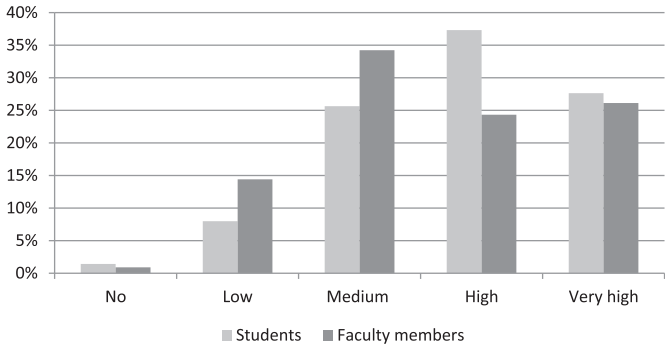

Fig. 5. Respondents' beliefs about AFVs as the most environmentally friendly choice for personal transportation as compared to conventional vehicles or other fuel types.

decisive factor in shaping a positive attitude toward environmental issues and, subsequently, towards AFVs.

The respondents were also asked to describe their main concerns about AFVs. These concerns were related to battery performance, charging infrastructure, high purchase cost, emissions, performance and reliability. The responses for students and faculty members were quite similar, as shown in Fig. 4.

Our results relating to concerns about AFVs show that important barriers to their deployment include both the range of battery autonomy and the lack of sufficient recharging infrastructure. It should be noted that the faculty members were relatively more sensitive than the students to these issues. In particular, concerns about battery autonomy were expressed by 40% of the faculty members compared to 30% of the students.

Indeed, the use of a new technology requires complementary technologies that might not be available or are expensive to use. In the case of AFVs, the development of battery charging infrastructure is necessary [45]. The additional cost of AFVs was also an important barrier for our respondents. As has been the case for many new technologies, high costs can create an adverse circle of chain reactions. In particular, high initial prices lead to low consumer satisfaction, low demand and a lack of investment interest with, consequently, no-mass production lines and thus high purchase prices. This circle can be broken in many ways, such as through public policies aimed at spurring interest in investment, which in turn leads to mass-production lines, large-scale sales, low initial prices and high consumer satisfaction, that is, high demand

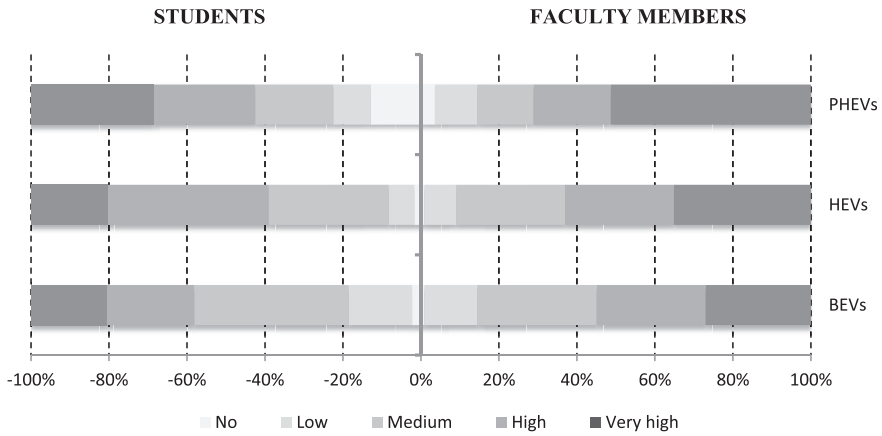

Fig. 6. Respondents' interest rank in terms of which mode of transport is more environmentally sustainable.

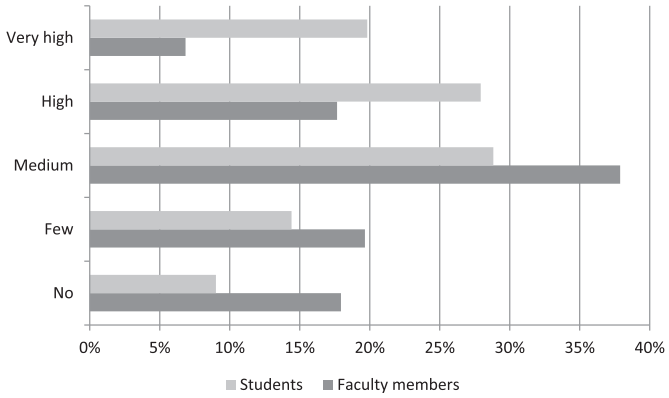

Fig. 7. Concerns about charging times.

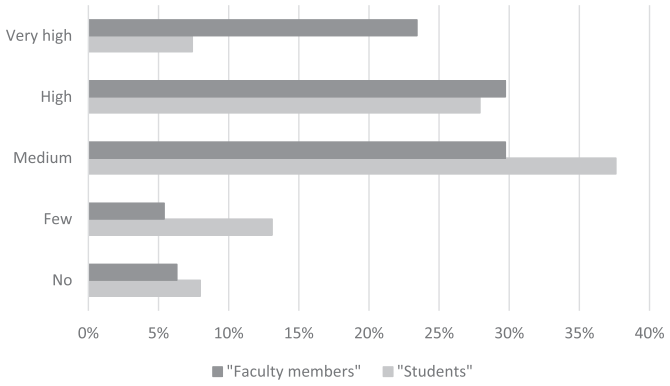

Fig. 8. Interest toward battery exchange service.

[46].

Additionally, analysing the environmental issues more in depth, we found some indications of the relevance of psychological factors. Indeed, another important finding is that the respondents regarded AFVs as a sustainable transport mode from an environmental point of view,[1] and the students were more likely to associate AFVs with low emissions of carbon dioxide and cleaner air (Fig. 5).

The latter is an important result because it means that the respondents have related a particular symbolic meaning (i.e. environmentalism) to AFVs. Some empirical research has shown that, among the different purchase motives, consumers concerned about preserving the environment are likely to take action to reduce their ecological footprint [10]. This result suggests that the respondents who displayed a pro-environmental attitude, represented by their agreement with the statement that 'AFVs are the most suitable choice for personal transportation compared to conventional vehicles or other fuels', have significantly more interest in buying AFVs [9]. An interesting study conducted by Fujii and Ohta [47] demonstrated that the potential environmental benefits of switching from conventional vehicles to AFVs depend on stable levels of consumption. In particular, they found that drivers who perceived their vehicles as being environmental friendly drove 1.64 times further than those that had conventional vehicles, thus resulting in a rebound effect.

Both students and faculty members perceived PHEVs to be less polluting than EVs and HEVs (Fig. 6). PHEVs differ from EVs because they use energy sources (hydrocarbon-based fuel stored in the fuel tank) other than electricity, and the batteries usually have a lower capacity. At the same time, PHEVs differ from HEVs due to their higher battery capacity, the existence of an appropriate electrical outlet (plug) to recharge the batteries from the electric grid and a different battery charging management strategy [48].

In our questionnaire survey, the faculty members indicated a high level of concern about the charging times (44% indicated high or very high concern) while the students demonstrated less concern (24% expressed very high concern) (Fig. 7).

Note that both groups appeared to be equally informed about the technical features of the charging operation. When asked how much time they thought the rapid charge should last, 55% of both the faculty members and students responded less than 10 min. This shows that both groups place less value on the time needed for the charging operation, and they are also less concerned with the implicit costs of new technologies (i.e. they are more favourable to new technologies).

It should be stressed that, according to our results, both groups very much liked the idea of a battery exchange service (it would consist in taking charged batteries and exchanging them

[1] Indeed, AFVs are sustainable only if powered by electricity produced from renewable energy sources [55,56]. However, if powered by electricity produced from coal fired power plants, AFVs are still low emission vehicles and cleaner than conventional vehicles. In addition, AFVs provide relief from local pollution in large urban areas, reducing the concentration of emissions in the air and therefore improving the quality of life. Thus, there can be a net societal benefit at the local level, even if the electricity is generated with conventional sources [57,58].

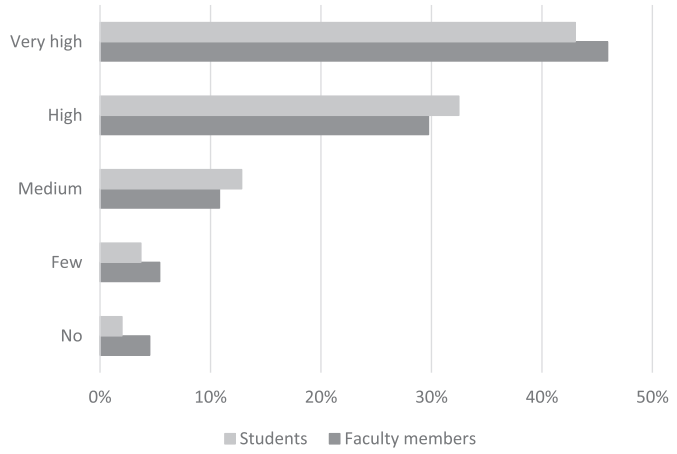

Fig. 9. Interest level for separating the car and the battery.

discharged ones) (over 65% of students and faculty members), as it is shown in Fig. 8.

However, when asked if they were interested in the possibility of separating the car and the battery, such that a monthly charge would be levied (like a cell phone service payment) for the battery handling and charging operations, the faculty members group was less favourable (28%) than the students (35%), showing once more than students are more flexible toward new technologies (Fig. 9).

Overall, the factors that promoted positive attitudes towards AFVs in the adult Italian consumers include environmental benefits and values and a reduction in fuel consumption or overall costs. The students were mainly influenced by lower refuelling costs, and they showed more interest, on average, in new technologies such as AFVs compared to the faculty members.

Thus, the results demonstrate the different dimensions of each AFV-related factor and their roles in influencing AFV purchase decisions in relation to age.

As far as concerns our initial hypotheses, some interesting conclusions emerge from the empirical investigation. Hypothesis 1 ("The higher the price of AFVs is, the more consumers are willing to buy them") is rejected at 10% of significant level. However, when all costs are considered, such as fuel economy savings, cost of air pollution for conventional cars fuelled by gasoline or by diesel [49], consumers might be more willing to pay a higher premium for AFVs.

Hypothesis 2 ("Longer charging times negatively affect consumers' willingness to adopt AFVs") is rejected at 10% of significant level only for faculty members. Dong et al. [50] showed that installing high numbers of public chargers particularly at the activity destinations where the vehicle is parked for a considerable period of time, allow to recharge the battery, and thus waiting time would no more cause inconvenience for AFVs' drivers. In the case of students, charging does not negatively affect their willingness to adopt AFVs because it might be that students can "plan their time accordingly", given that they have more free time than workers.

Hypothesis 3 ("Students who care about their self-image, are more willing to buy AFVs") is rejected at 5% of significant level. According to Kim et al. [51]; age and household income significantly affect the behaviour changes, with older people, with higher personal satisfaction with 'social and economic perspective', more likely to purchase AFVs than young adult. However, Chua et al. [52] showed that young population (22–30) are likely to purchase AFVs for social reasons, with the aim of projecting a "green" image about themselves on the community.

Hypothesis 4 ("Environmentalism is a bad predictor of adoption levels") is rejected at 10% of significant level. Silvia and Krause [53] found that, among others, environmental attitudes are key factors that interact with vehicle to positively influence AFVs purchase decisions. Individuals who are concerned about climate change perceive stronger reflections of environmentalist which in turn leads to stronger intent to adopt EVs [54].

4. Conclusions

Our paper analysed the impact of age on consumers' attitudes towards alternative fuel vehicles by conducting a survey within university students and faculty members of the University of Perugia, Italy. The findings provide useful insights into the effects of age differences on AFV purchasing decision-making process.

AFVs are recognised as one of the most promising alternative technologies for reducing petroleum dependency and carbon dioxide emissions. In addition, EVs produce zero emissions from the tailpipe and therefore could significantly contribute to improved urban air quality. Electricity can be produced from any primary energy source, including biomass, wind and solar energy, offering the opportunity to break the link between oil and transport. The results indicate that, among the sample, there is still not an adequate knowledge about AFVs, although it is a highly technical issue.

The majority of the respondents agreed that AFVs might contribute to climate change mitigation and decrease the use of oil. Most of the respondents agreed that AFVs have lower refuelling costs but very high capital expenditure costs.

The concerns and difficulties that consumers face when trying to make green choices were highlighted in relation to age differences.

From our descriptive analysis, it turns out that, first, information campaigns promoting AFVs should be targeting students in order to improve to involve them in sustainability issues related to transport. Indeed, according to our results, faculty members are more informed and interested in AFVs. Second, there is the need for policy makers to improve regulations to enhance the infrastructure needed to deploy and diffuse these technologies.

A better understanding of the effects of different ages on attitude processes is crucial for designing more effective private and public strategies for alternative fuel vehicles' development across a variety of consumers.

For instance, faculty members value climate change mitigation and reducing oil consumption more than students. This might imply that faculty members show a higher degree of awareness and responsibility for providing a better world for future generations. The discussion within our paper is by no means exhaustive and it cannot be generalized to the whole society, and other areas of potential interest to age and consumer attitude certainly exist, such as investigation of cultural influences on age-related changes in consumer attitude, and the inclusion of less-educated people.

Further research on age-related attitude toward alternative fuel vehicles will add to the literature insights into how attitude processes can be improved across the life span.

Appendix

Questionnaire: Attitude toward alternative fuel vehicles.

Age (years)					
Province of residence					
				Male	Female
Gender					
	≤ 10.000	10.001-20.000	20.001-30.000	30.001-40.000	≥ 40.001
Income (household income) (€)					
Daily average travel distance travelled (km)					

	Almost never				Almost always
	1	2	3	4	5
Usual transportation mode					
private car					
bus					
train					
motorcycled					
bike					
walk					
Have you have ever tried AFVs?	Yes	Not			
BEVs					
HEVs					
PHEVs					
	No				Very high
	1	2	3	4	5
Level of respondent's interest in AFVs					
	Strongly disagree				Strongly agree
	1	2	3	4	5
Attractiveness of AFVs' related benefits					
reducing oil consumption					
climate change mitigation					
cost significantly less to fuel					
low level of noise					
less maintenance					
	Strongly disagree				Strongly agree
	1	2	3	4	5
Concerns about AFVs					
driving range					
charging station infrastructure					
purchasing costs of AFVs and cost of batteries					
reliability					
safety					
charging time					
less performance					
	No				Very high
	1	2	3	4	5
Respondent' belief about AFVs as the most environmental friendly choice for personal transportation compared to other fuels					
	No				Very high
	1	2	3	4	5
Respondent's interest rank in terms of which mode of transsport is more environmental friendly					
BEVs					
HEVs					
PHEVs					
	No				Very high
	1	2	3	4	5
Concerns about charging times					

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